



Simulation of Bollworm Damages on Cotton

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Context : Pests & Cotton in West Africa...

Bollworms : variability in infestation (date, population)
Crop Management : rainfed conditions, low input (NPK, chemicals)

Helicoverpa armigera



Spodoptera littoralis



Earias biplaga



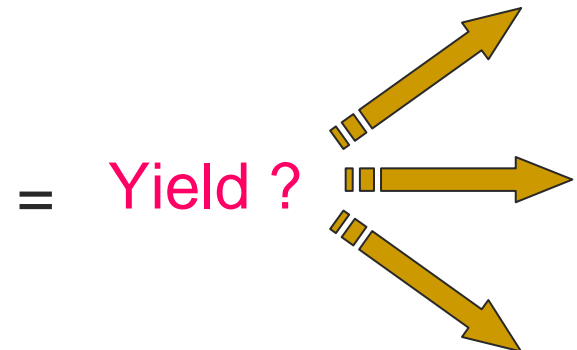
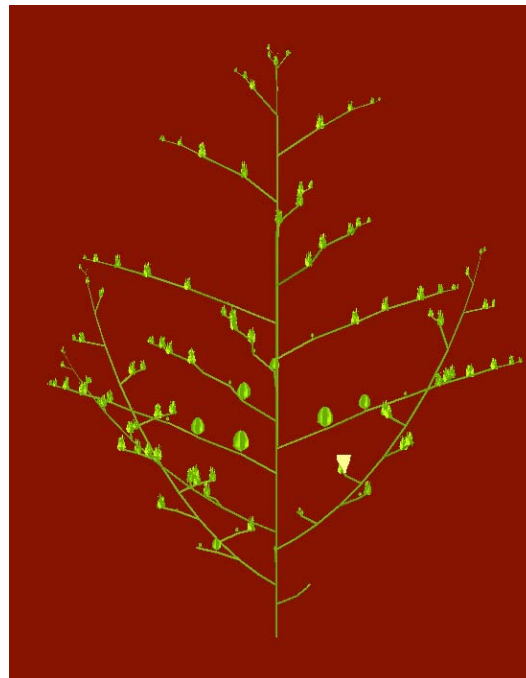
Diparopsis watersi



Crop characteristics :

- Undetermined growth habit
- Adaptation to environmental conditions (density, etc.)
 - ➔ High architectural plasticity

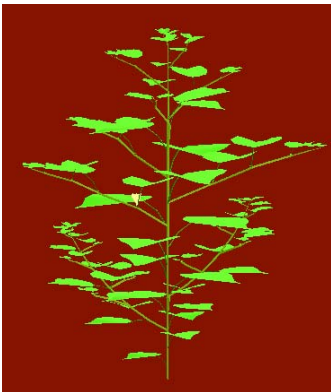
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Methodology

Crop and Bollworm model linkage

**Crop Model
(Gossym)**



**Buds & fruits
availability**

Linking
interface

Damages

**Bollworm model
(Cobold)**



**Yield
+
rotten cotton**

COBOLD

Simulation of bollworm population and injuries (CIRAD)



Model Input

- Air temperature (2m)
- Nb of larvae per larval instars and species

Laws included (hourly time step)

- Larval instar duration = $f(T^{\circ}\text{C})$
- Voracity : fresh matter consumption per larval instars (regardless organ type)
- Fresh matter consumed = $f(\text{organ fresh mass, larval instar})$
- Feeding preference : stochastic per fruit type
- Organ shedding : rules based on observations
- Mortality table due to natural enemies

Bibliography

Lab. experiments

Field experiments

Bibliography

GOSSYM

Cotton Crop Model (USDA-ARS)

Model Input

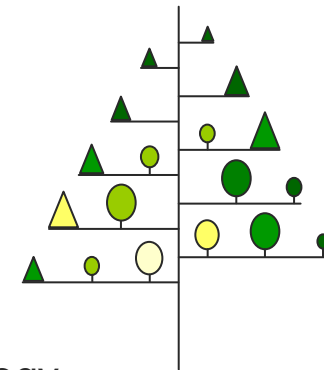
- Soil characteristics (H₂O + MO)
- Climate (T°C, radiation, rainfall ...)
- Cultural practices (planting, irrigation, fertilizer ...)





Biophysical Processes (daily time step)

- Photosynthesis
- Phyllochrone (leaves + fruits)
- Partitioning rules (vegetative vs reproductive)
- Shedding rules (physiological)



Average plant “pseudo”-architecture



- Topology
- Each position characterized by
 -   a status : bud, fruit
 -  a dry mass
 -  a % of presence

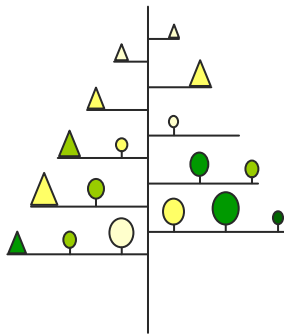
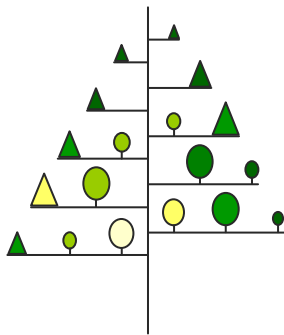
Linkage, a complex operation...

1/3

Inducing coincidence of organization levels ...

Example : fruit representation

Gossym



Numerical
derivation

Resource :

Collection of reproductive organs



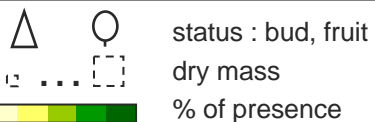
Cobold



Organ consumption per position :

- damages → mass
- shedding → number

Numerical
integration

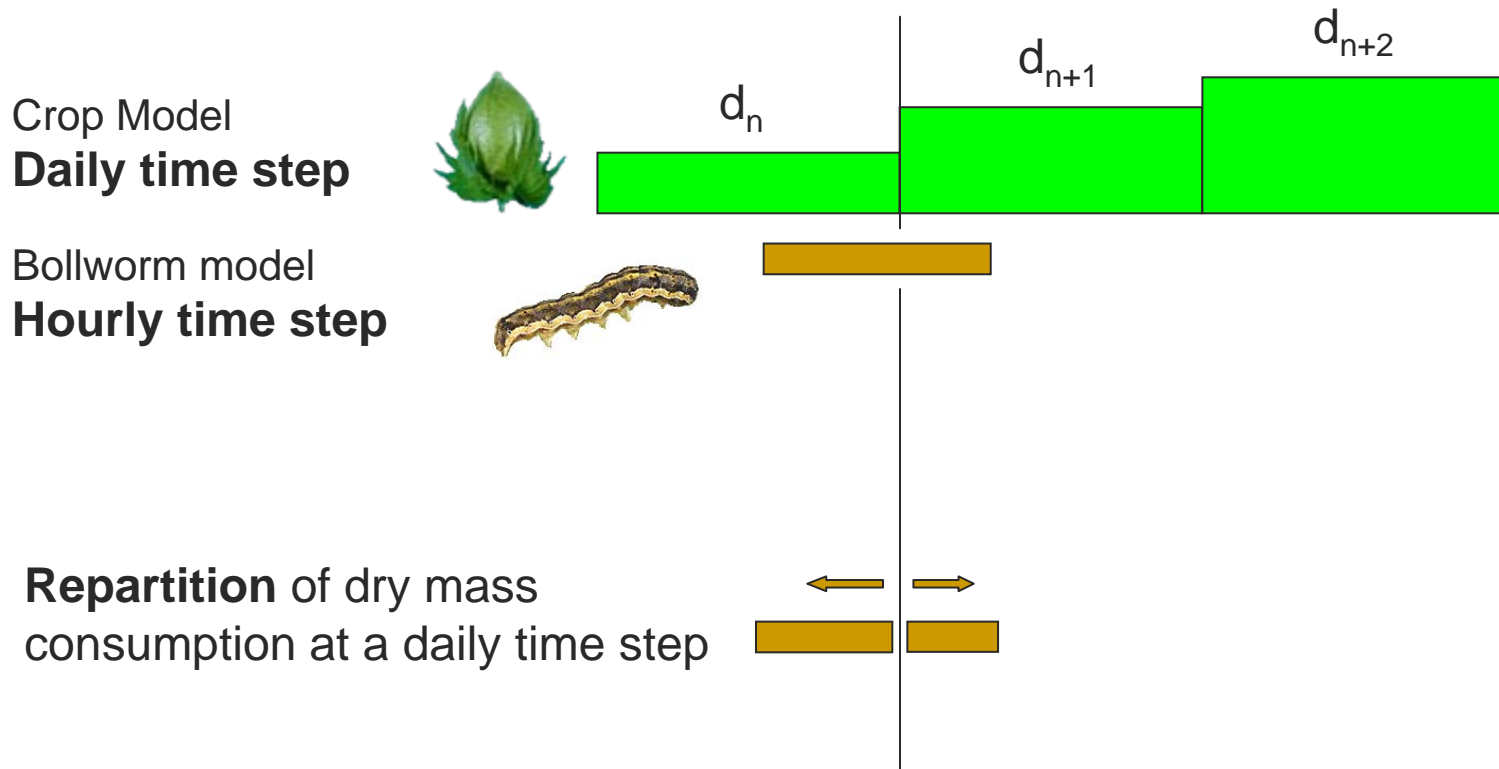


Linkage, a complex operation...

2/3

Inducing coincidence in time, space and energy...

Example : fruit consumption



Linkage, a complex operation...

3/3

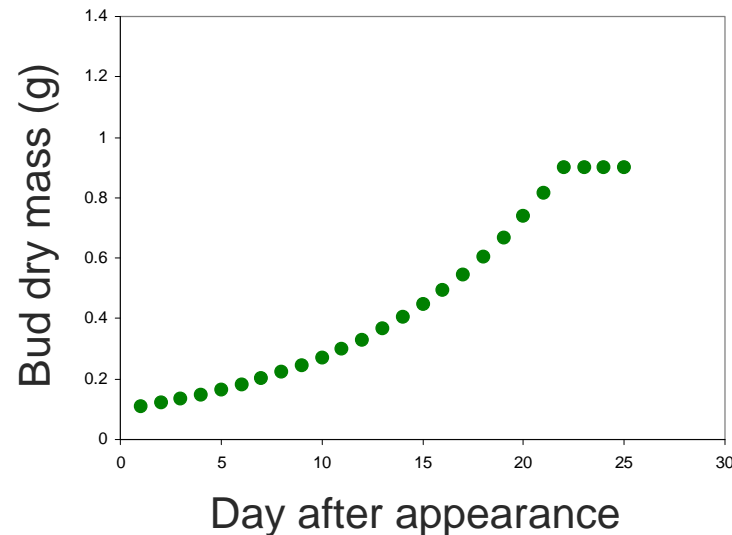
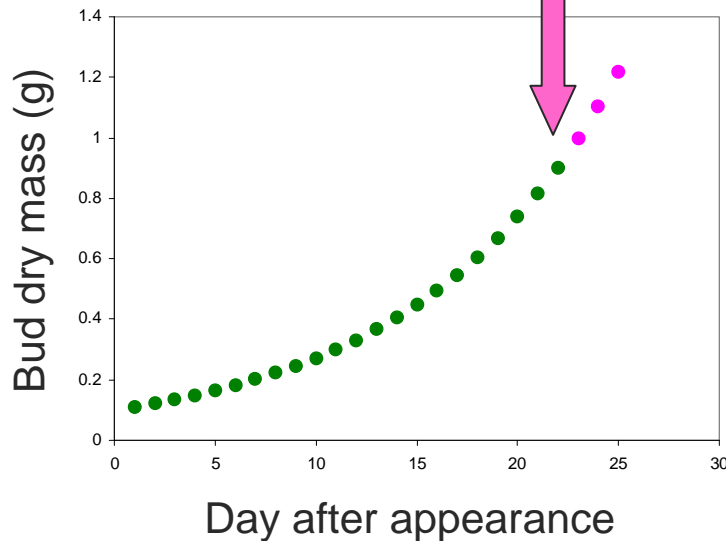
Inducing coherence of modelling options...

Example : bud mass exponential growth



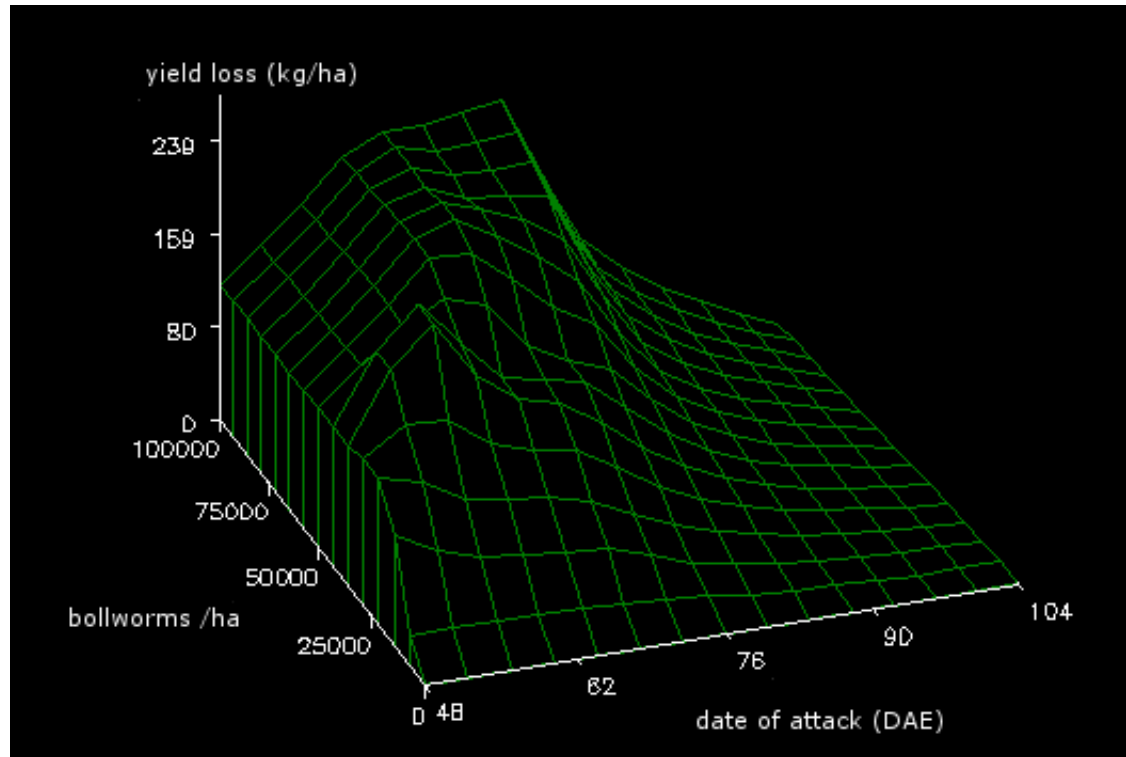
→ **Sensitivity** to flowering date :

- **low** on crop model (negligible)
- **high** on damage simulation



Results

Example : simulation of yield loss ...



Maroua experimental station, Cameroun, 2004

Perspective

Towards a DSS...

Actual Status :

- Validation of COBOLD is under progress with on-station trials
- publications : laws already published, COBOLD architecture submitted

COBOLD is the core of a future DSS :

- Aim : allow the adjustment of economic injury levels according to :
weather (mainly rain), sowing dates, evolution of seed cotton and
chemical prices
- End-users : technical advisers (cotton companies)